



# Free Reign: Building Visual Effects for Player Agency in Just Cause 3

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**Avalanche Studios**



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# Just Cause 3

- Just Cause 3 is a big open world game.
  - How do you build effects in a game where a player can do whatever they want?



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# Free Reign: Overview

- Visual effects overview
  - Parameters
  - Lighting solutions: Dynamic Time of day
  - Explosions
  - Destruction
  - Automobiles
  - Performance





# Engine: Avalanche Effects Tool

- All VFX tools have their key feature



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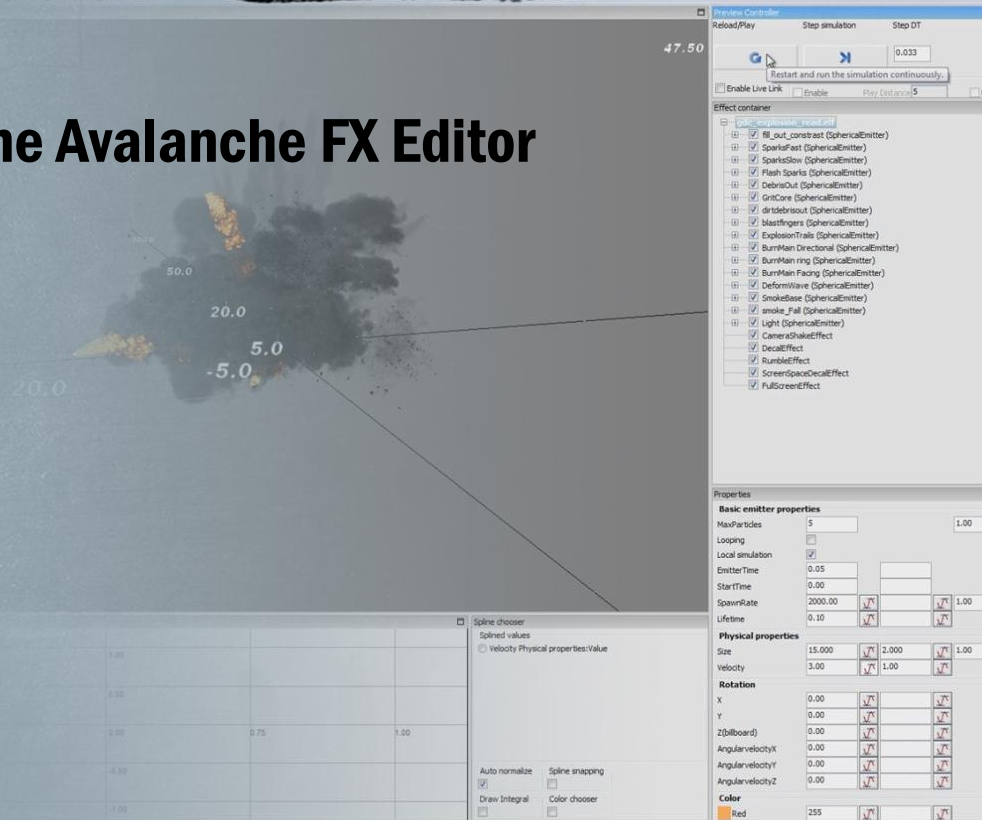
# **Engine:** Avalanche Effects Tool

- All VFX tools have their key feature
- Avalanche Effects tool
  - Loads of Overdraw
  - In game feedback (parameters)



# Avalanche VFX Tool: Features

- Building FX at Avalanche with the Avalanche FX Editor
  - What does it do?
    - Sprites and meshes
      - modifiers (over time)
    - Third party tools
    - Culling ranges per VFX





# VFX: Parameters?

- **What's the big deal?**
  - **generic**
  - **object specific**



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# VFX: Parameter examples

mass  
height\_above\_ground  
height\_above\_sea\_level  
height\_above\_ground\_or\_sea\_level  
ground\_height\_below\_vehicle  
ground\_effect\_strength  
pitch\_rad  
roll\_rad  
tilt\_rad  
speed\_ms  
speed\_forward\_ms  
speed\_right\_ms  
speed\_up\_ms  
acceleration  
acceleration\_forward  
acceleration\_right  
acceleration\_up  
velocity  
angular\_velocity\_rads  
angular\_velocity\_yaw\_rads  
angular\_velocity\_pitch\_rads  
angular\_velocity\_roll\_rads  
gear  
engine\_timeline  
engine\_real\_load  
engine\_rpm  
engine\_rpm\_min  
engine\_rpm\_max  
engine\_rpm\_norm  
engine\_rpm\_smooth  
engine\_rpm\_smooth\_norm  
engine\_audio\_rpm  
engine\_audio\_rpm\_smooth  
engine\_torque  
engine\_torque\_max

engine\_torque\_norm  
front\_left\_braking\_torque  
front\_right\_braking\_torque  
rear\_left\_braking\_torque  
rear\_right\_braking\_torque  
front\_left\_tire\_temperature  
front\_right\_tire\_temperature  
rear\_left\_tire\_temperature  
rear\_right\_tire\_temperature  
front\_left\_skid  
front\_right\_skid  
rear\_left\_skid  
rear\_right\_skid  
front\_left\_spin  
front\_right\_spin  
rear\_left\_spin  
rear\_right\_spin  
front\_right\_suspension\_length  
front\_left\_suspension\_length  
rear\_right\_suspension\_length  
rear\_left\_suspension\_length  
front\_wheels\_down\_force  
rear\_wheels\_down\_force  
front\_wheels\_side\_force  
rear\_wheels\_side\_force  
front\_wheels\_forward\_force  
rear\_wheels\_forward\_force  
front\_wheels\_forward\_impulse  
rear\_wheels\_forward\_impulse  
front\_wheels\_forward\_slip\_velocity  
rear\_wheels\_forward\_slip\_velocity  
front\_wheels\_side\_slip\_velocity  
rear\_wheels\_side\_slip\_velocity  
front\_wheels\_side\_force\_scaled  
rear\_wheels\_side\_force\_scaled

front\_wheels\_forward\_force\_scaled  
rear\_wheels\_forward\_force\_scaled  
front\_wheels\_relative\_side\_force  
rear\_wheels\_relative\_side\_force  
front\_wheels\_relative\_forward\_force  
rear\_wheels\_relative\_forward\_force  
front\_right\_rolling\_effect  
front\_left\_rolling\_effect  
rear\_right\_rolling\_effect  
rear\_left\_rolling\_effect  
front\_right\_skidding\_effect  
front\_left\_skidding\_effect  
rear\_right\_skidding\_effect  
rear\_left\_skidding\_effect  
front\_right\_spinning\_effect  
front\_left\_spinning\_effect  
rear\_right\_spinning\_effect  
rear\_left\_spinning\_effect  
front\_right\_slipping\_effect  
front\_left\_slipping\_effect  
rear\_right\_slipping\_effect  
rear\_left\_slipping\_effect  
combined\_wheel\_rolling\_effect  
combined\_wheel\_skidding\_effect  
combined\_wheel\_slipping\_effect  
combined\_wheel\_spinning\_effect  
combined\_notyre\_effect  
wheel\_suspension\_effect  
wheel\_suspension\_impact\_effect  
chassis\_stress\_effect  
turn\_input  
turn  
steering\_angle  
steering\_angle\_max  
steering\_angle\_norm

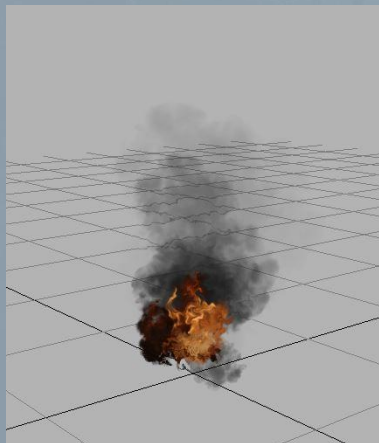
fast\_turn\_torque  
high\_speed\_turn\_force  
extra\_acceleration  
air\_height\_above\_ground  
number\_of\_wheels\_on\_ground  
land\_number\_of\_wheels  
land\_number\_of\_wheels\_on\_ground  
land\_number\_of\_wheels\_on\_ground\_norm  
air\_number\_of\_wheels  
air\_number\_of\_wheels\_on\_ground  
air\_number\_of\_wheels\_on\_ground\_norm  
ground\_roughness  
dive\_input  
current\_depth  
desired\_depth  
normalized\_desired\_depth\_delta  
depth\_control\_error  
depth\_control\_proportional\_output  
depth\_control\_integral\_output  
depth\_control\_derivative\_output  
current\_pitch  
desired\_pitch  
pitch\_control\_error  
pitch\_control\_proportional\_output  
pitch\_control\_integral\_output  
pitch\_control\_derivative\_output  
pitch\_control\_torque  
current\_roll  
buoyancy\_modifier  
relative\_displaced\_volume  
nonsea\_relative\_displaced\_volume  
sea\_relative\_displaced\_volume  
nonsea\_buoyancy\_modifier  
sea\_buoyancy\_modifier  
sea\_engine\_force

sea\_rudder\_force  
sea\_engine\_force\_magnitude  
sea\_rudder\_force\_magnitude  
sea\_engine\_force\_position  
sea\_rudder\_force\_position  
speed\_ms  
chassis\_effect\_angular\_speed  
top\_speed\_ms  
speed\_norm  
locked\_missile\_distance  
locked\_missile\_count  
hit\_points  
hit\_points\_max  
health\_norm  
damage\_norm  
engine\_load  
wheelie\_amount  
wheelie\_torque\_amount  
wheelie\_angle\_limiter\_factor  
steering\_acceleration  
steering\_brake  
steering\_reverse  
steering\_turn  
steering\_tilt  
steering\_turn\_x  
steering\_turn\_y  
steering\_altitude  
steering\_handbrake  
steering\_signal\_horn  
steering\_desired\_altitude  
steering\_yaw  
steering\_pitch  
steering\_roll  
steering\_roll\_inverted  
rotor\_rpm

train\_listener\_width  
landing\_gears\_T  
hatches\_T  
air\_brakes\_T  
flaps\_T  
front\_hardpoint\_center\_local  
rear\_hardpoint\_center\_local  
drift\_amount  
speed\_rom\_speed\_factor  
main\_rotor\_rpm\_norm  
tail\_rotor\_rpm\_norm  
engine\_damage  
helicopter\_control\_error  
tail\_rotor\_efficiency  
main\_rotor\_efficiency  
vehicle\_smoking  
vehicle\_burning  
interpolated\_transform  
center\_of\_mass\_local  
inertia\_tensor  
is\_player\_controlled



# VFX: Parameter how...

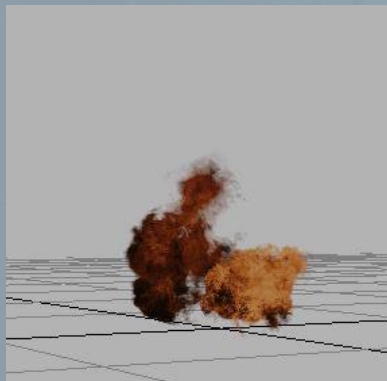


- **Make the base effect**



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# VFX: Parameter how...



- **Make the base effect**
  - **Pick a parameter for the emitter**
    - **In this case 'Speed'**



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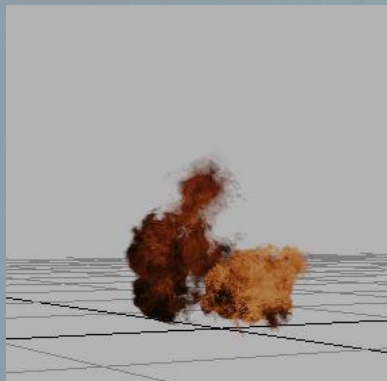


- 
- A line graph with a horizontal axis and a vertical axis. A red line starts at the origin (0,0) and extends linearly to the point (1,30). The horizontal axis is unlabeled, and the vertical axis is labeled with '0' at the origin and '30' at the end of the line. The line is straight, indicating a constant rate of change.



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# VFX: Parameter how...

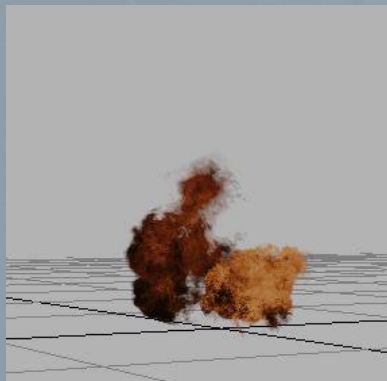


- **Determine what to do: Size scale**

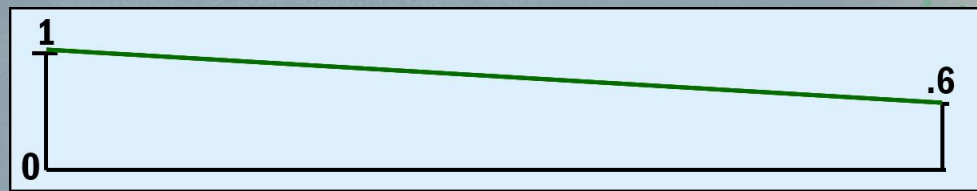


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# VFX: Parameter how...



- Determine what to do: Size scale
  - Min scale 1 Max scale .6



```
splash_out_01  
PhysPhysImpulse 0.000000  
Velocity 45.04517041108112843 0.118
```

cars

000000

dust  
sand

8.218299

Precipitation : 0.000000

WheelOff : 18.888183

0.000000

Velocity : 2.649000 -0.000000 -7.911036

Speed : 7.700990

Precipitation : 0.000000

WheelOff : 18.888183

Velocity : 2.649000 -0.000000 -7.911036

Speed : 7.700990

Precipitation : 0.000000

WheelOff : 18.888183

Velocity : 2.649000 -0.000000 -7.911036

Speed : 7.700990

Precipitation : 0.000000

WheelOff : 18.888183

Velocity : 2.649000 -0.000000 -7.911036

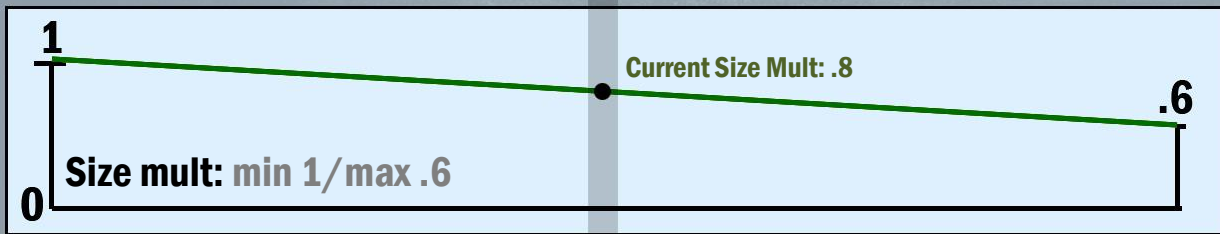
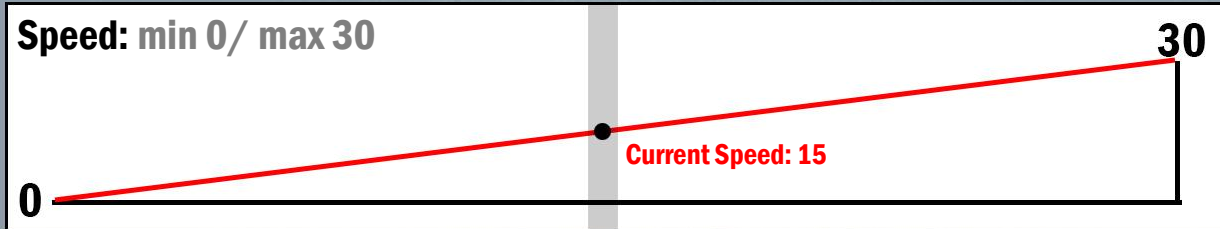
Speed : 7.700990



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# VFX: Parameter how...



Init sprite size: 2

At speed 0: size = 2

At speed 15: size = 1.6

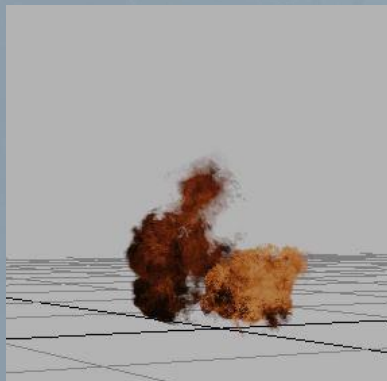
At speed 30: size = 1.2



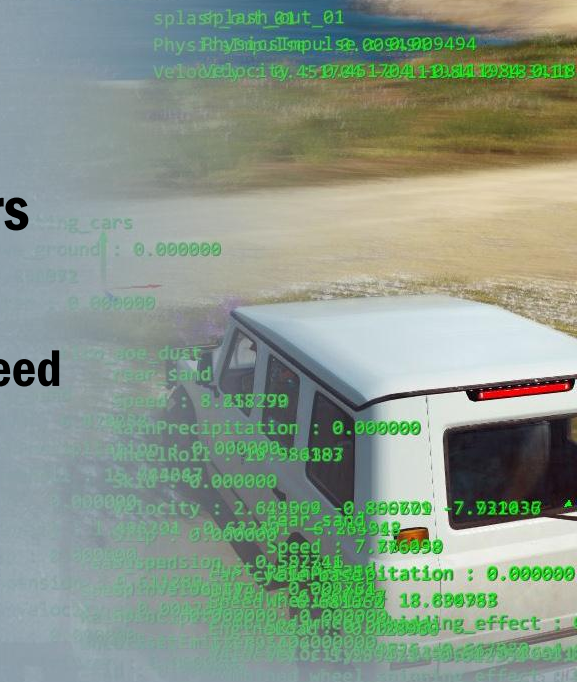
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# VFX: Parameter how...



- **but that's not all!**
  - **Speed tied into other modifiers**
    - **Lifetime drops based at speed**
    - **The spawn rate is quickened at speed**
      - **Spawn rate is an add not mult.**



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# VFX: Why Parameters

- **Why use parameters?**
  - **Dynamic variety**
  - **Efficient use of effects and time**
  - **Couldn't afford to do a ton number of one off assets**
    - **Although there are still cases for one off VFX assets**



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# VFX: Parameters cost

- **Two different modes**
  - **First frame only**
  - **Per Frame update**



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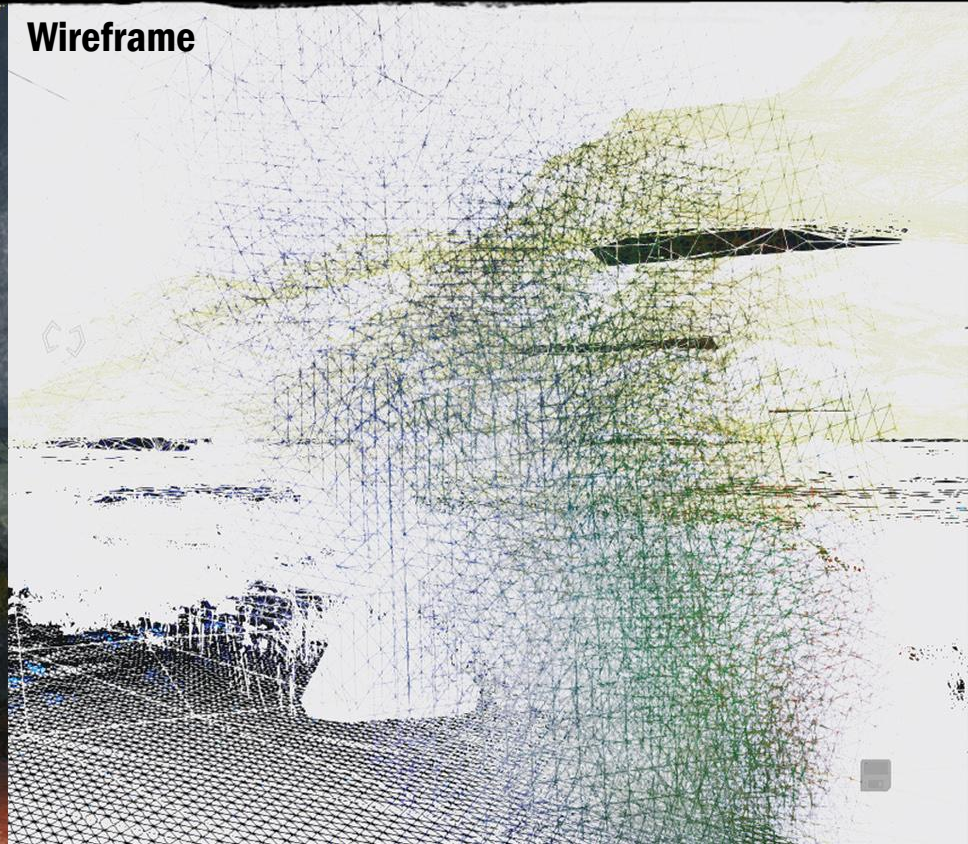


# VFX: Lighting Tessellated Sprites

Lit



Wireframe



# **VFX: Lighting**

- **Dynamic lighting for Visual FX**
  - Ambient light from the world
  - Dynamic Light from point and spot lights
  - Cloud shadows
  - Horizon map: shadow map for terrain



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# VFX: Lighting TOD



# VFX: Lighting

- **Spherical normal**
  - **Secondary texture call**
    - **Applied to animated sprites and static sprites if needed**
    - **Backlight influence controls light scatter**



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# **VFX:** Backlight Day

Zero Influence



Half Influence



Full Influence





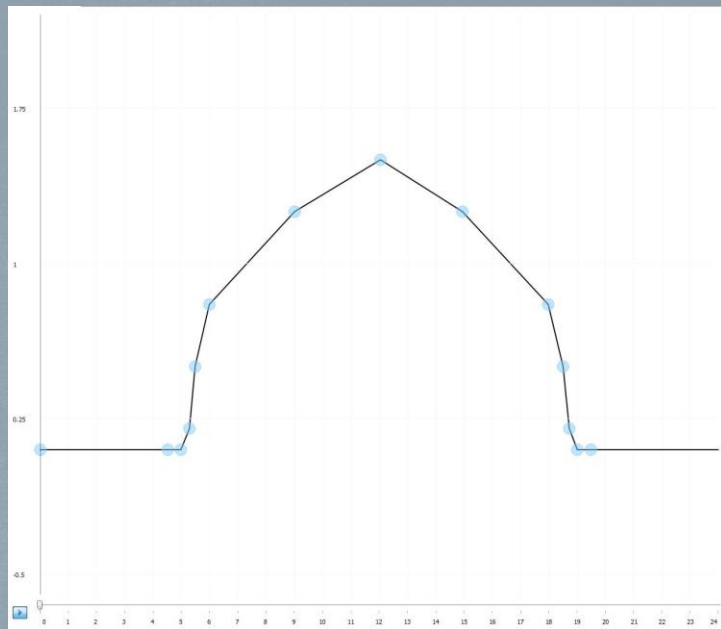
# VFX: Bloom



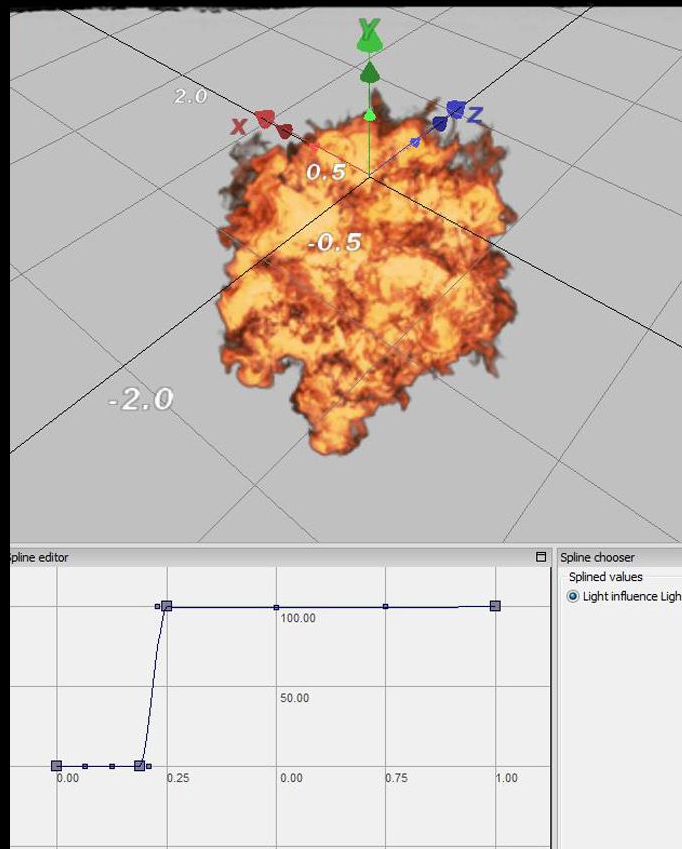
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# VFX: Bloom and Light Influence

- **Bloom Scale: Activated Bloom per sprite as needed**
  - Time of day HDR controls only for sprites
- **Light Influence**
  - Base value and a also a curve
  - Great for fine tuning transitional light effects like explosions



# Explosion FX: Lighting control







# Explosion FX: Challenges

- Explosions as characters!
  - Ummm... what?



# Explosion FX: Challenges

- Explosions as characters!
  - Ummm... what?
- Creating good explosions is hard!



# Explosion FX: Overview

- **Explosions as characters!**
  - Reference: Real vs. movie explosions
  - Fatigue
  - Explosion themes
  - Building the asset
  - Forces applied





# Explosion FX: Reference



# Explosion FX: Fatigue

- **Everything is awesome = nothing is awesome**
  - **Players can be destroying in game for hours**
    - **So what did we do to deal with Fatigue?**



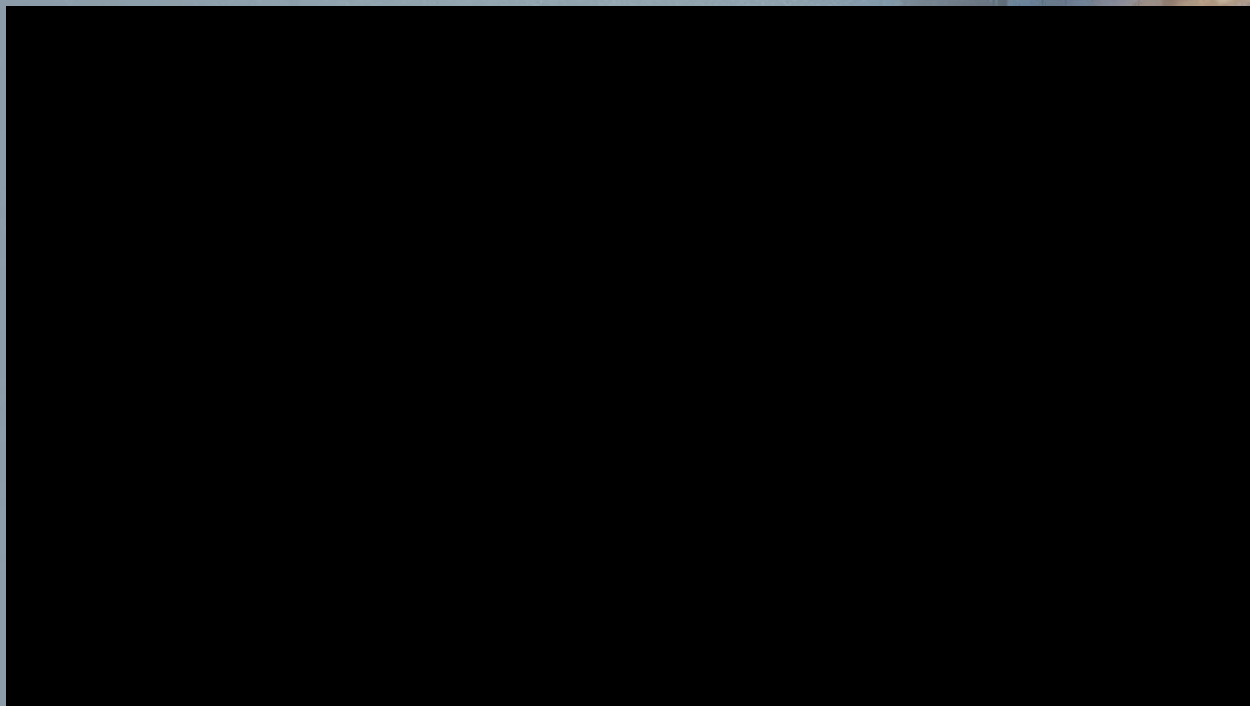


# Explosion FX: Themes



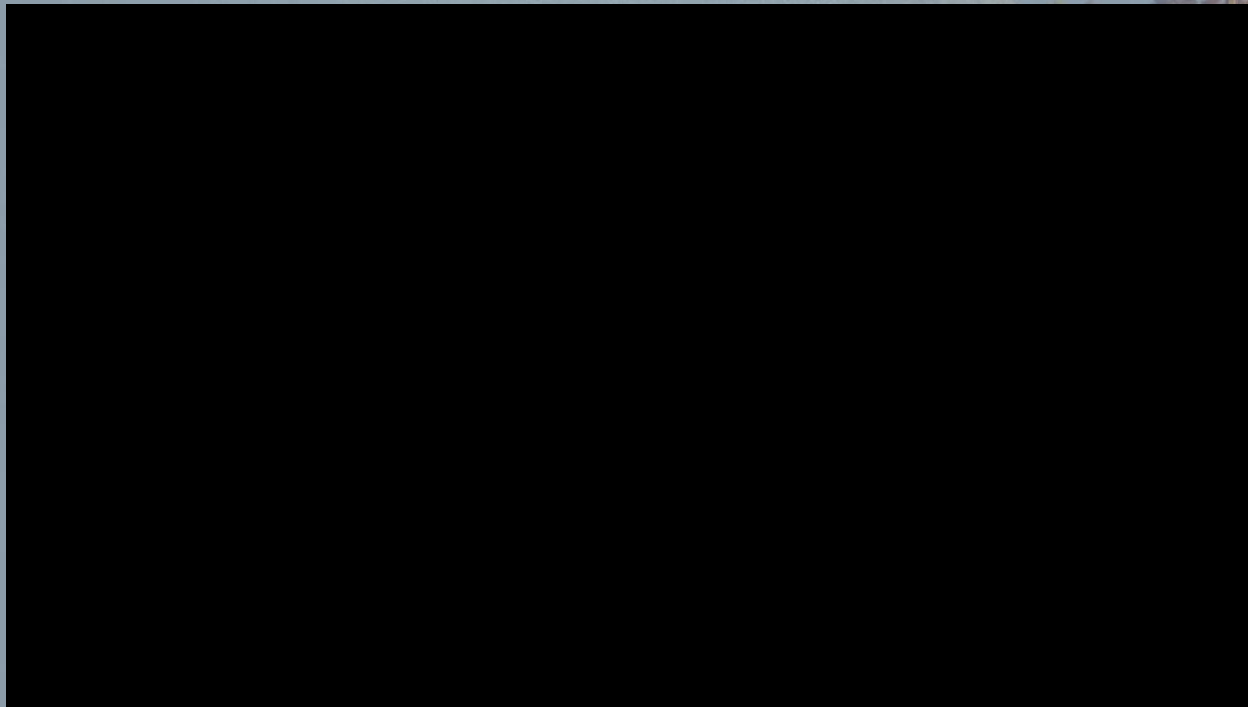
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# Explosion FX: Electrical Theme

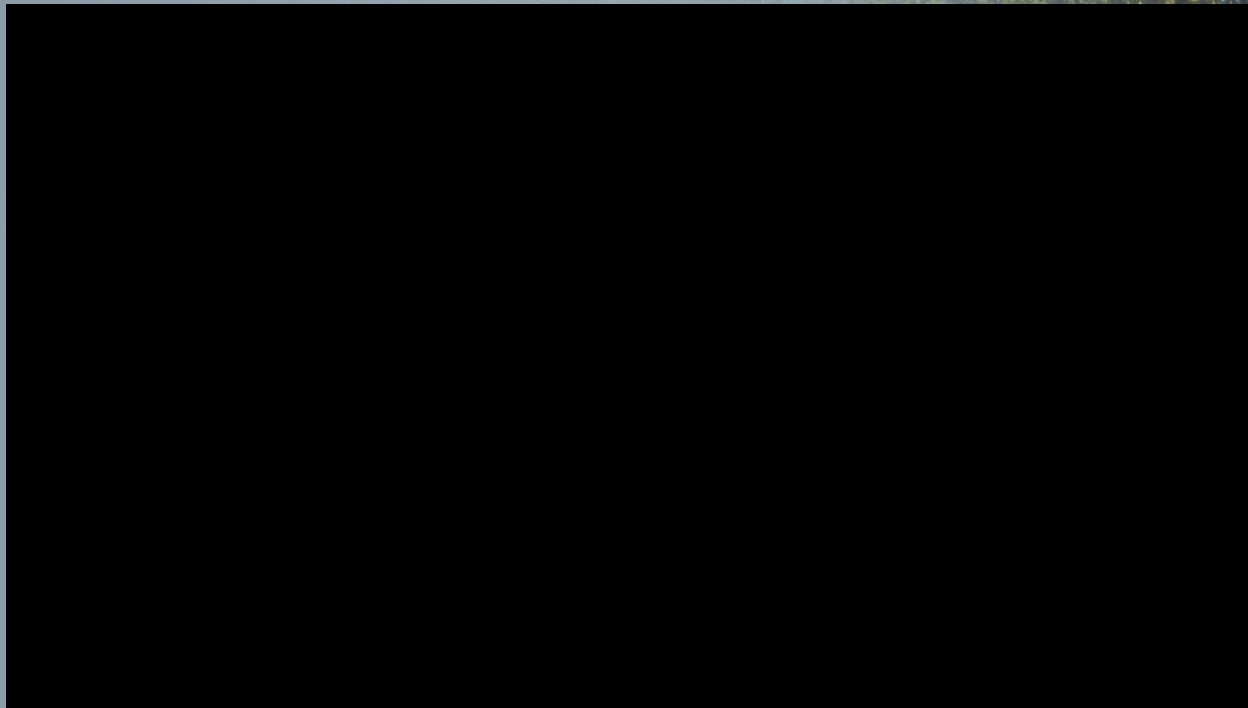




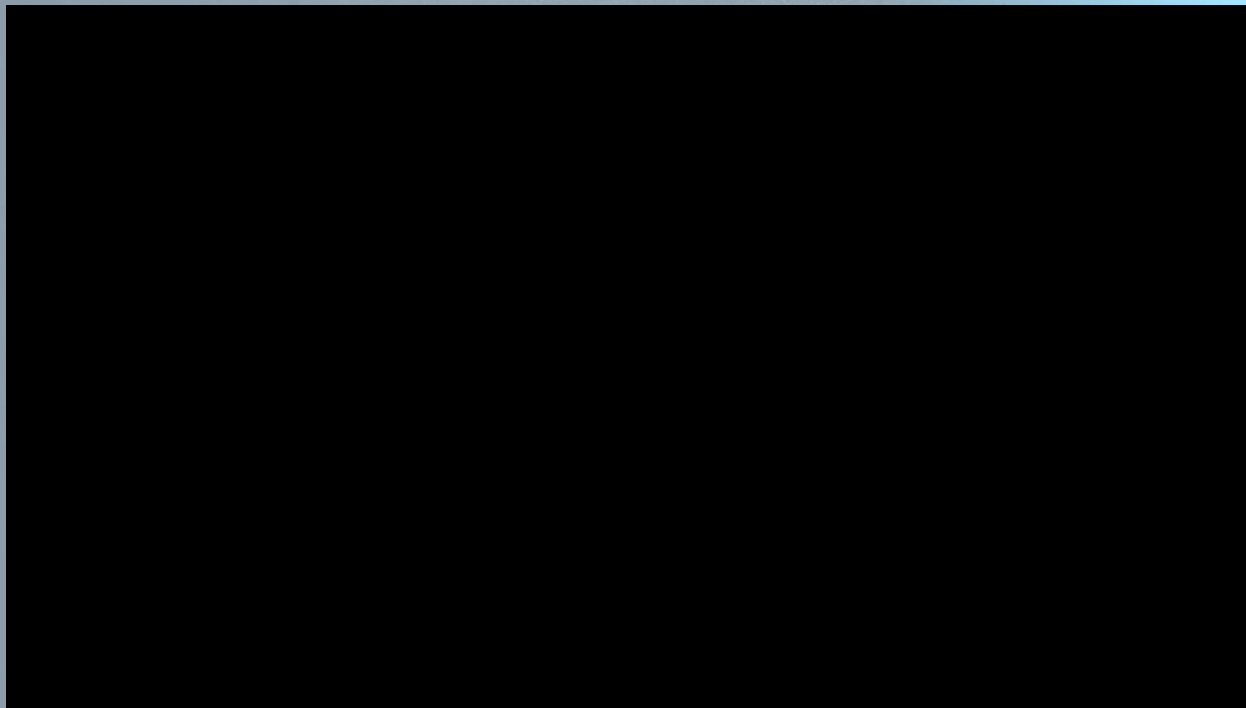
# Explosion FX: Fuel Theme



# Explosion FX: Concussion Theme

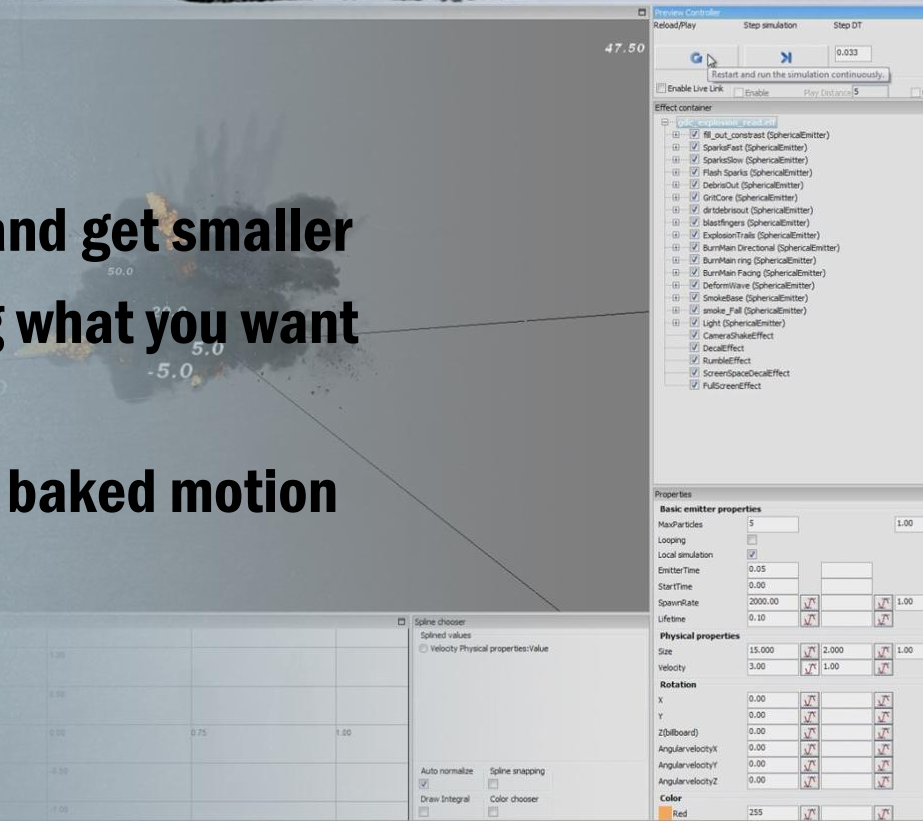


# Explosion FX: Bavarium Theme



# Explosion FX: Asset

- Building explosion reads
  - Start with large visual reads and get smaller
  - Layer detail on until it's doing what you want
    - Base asset has random ranges
  - Parameters = avoid too much baked motion

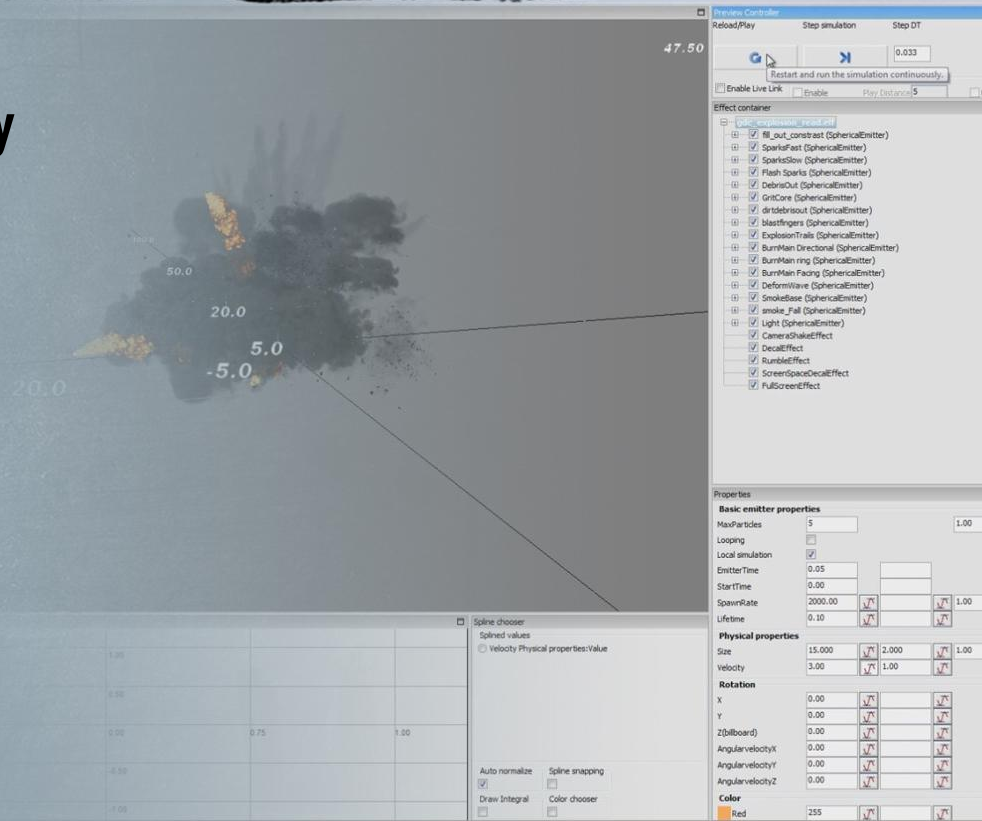






# Explosion FX: Asset Performance

- General VFX building rules apply
  - alpha test and particle trimming
- Post process activation cap









# **Destruction:** Overview

- Destruction Instance breakdown
- Chain Reactions
- For the Player!
- Havok® Destruction



# **Destruction:** Breakdown

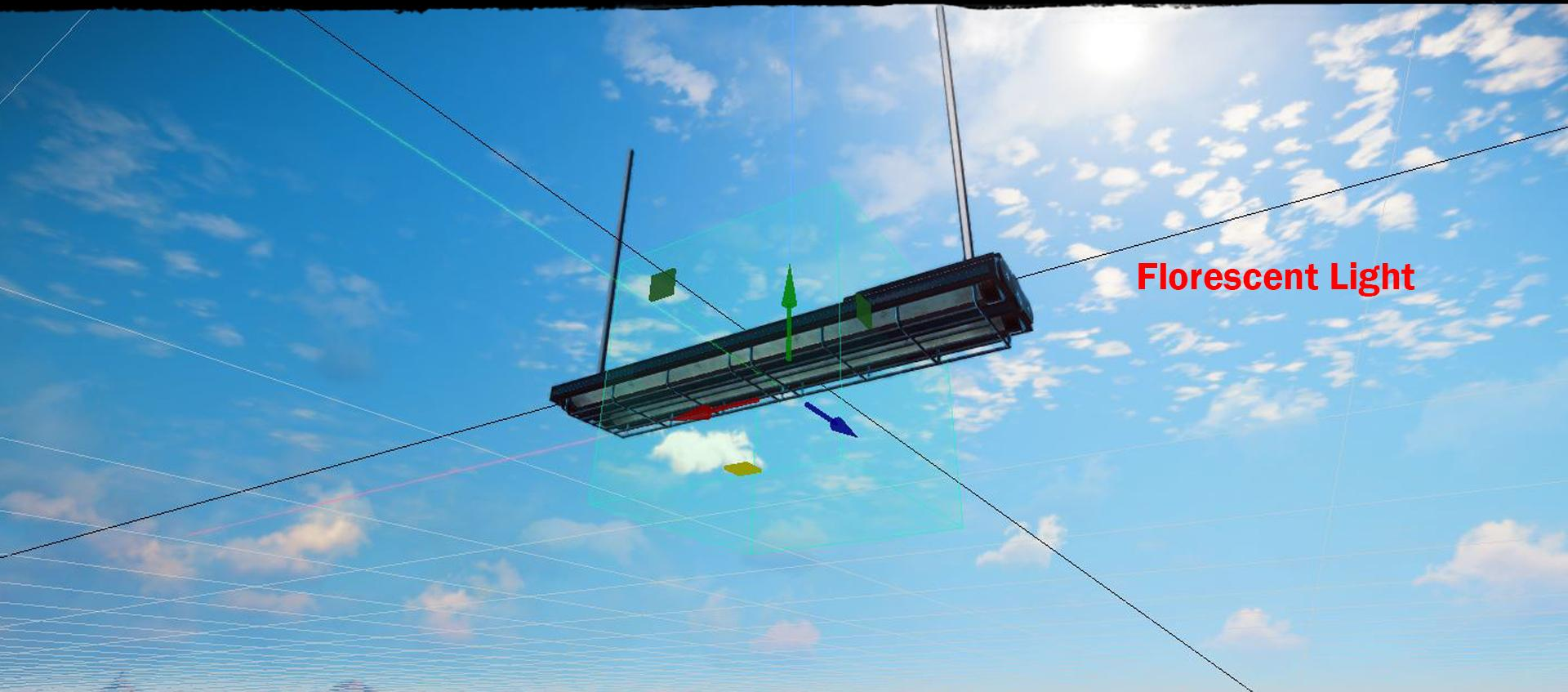




# Destruction: Breakdown



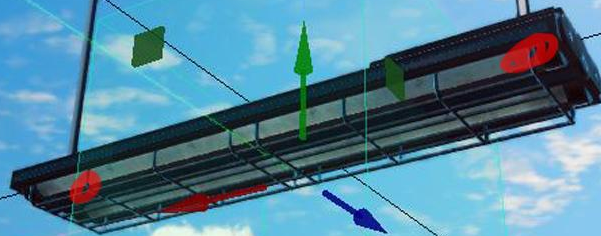
# **Destruction:** Breakdown



**Florescent Light**



# **Destruction:** Breakdown

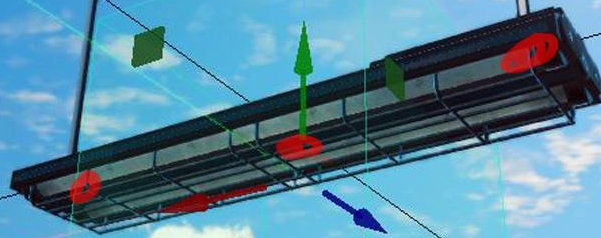


**Florescent Light**

2 Zap effects  
for constraint breaks



# **Destruction:** Breakdown

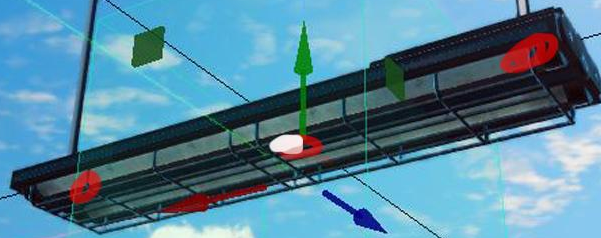


## **Florescent Light**

**2 Zap effects  
for constraint breaks**

**1 effect for break when  
the light is off**

# **Destruction:** Breakdown



## **Florescent Light**

- 2 Zap effects**  
for constraint breaks
- 1 effect for break when**  
the light is **off**
- 1 effect for break when**  
the light is **on**

**4 Effects total**



# Destruction: Breakdown





# **Destruction: Breakdown**

**a\_pump\_01**

**4 effects**

**1 force pulse**

**Used 8 times**

**32 VFX**



**FX count: 64**

# **Destruction: Breakdown**

## **a\_pump\_01**

**4 effects**

**1 force pulse**

**Used 8 times**

**32 VFX**



## **Gas\_disp\_02**

**5 effects**

**1 force pulse**

**1 thruster**

**Used 2 times**

**20 VFX**



**FX count: 84**



# Destruction: Breakdown

Camera Pos: -7252 -1239 -233 Dir: 6.742 -6.367 -0.952 Roll: 17.42



**Barrel ramp**

**14 effects**

**5 force pulses**



**1 effect**



**1 effect**



**2**

**FX count: a real lot**

**You get the  
idea**



# **Destruction:** Breakdown

## **Final Destruction**

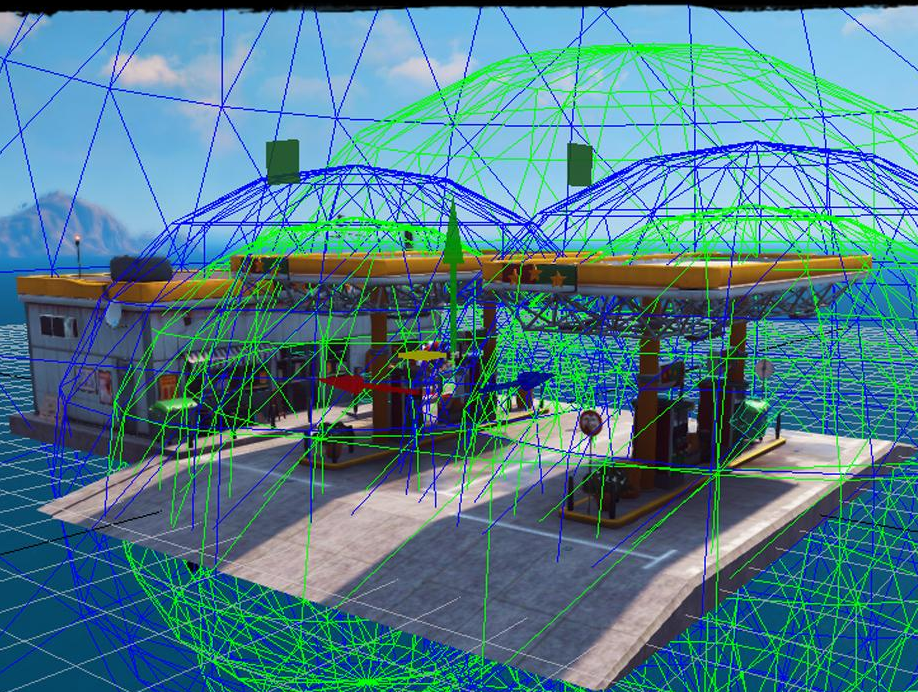
6 effects

5 small explosions

1 huge explosion

3 force pulses

On random timers



**FX count: ???**



# Destruction: Breakdown

All breakable: around 85+  
objects



FX count: ????

# **Destruction:** Breakdown





# **Destruction:** Chain Reactions

- Add all this together...
  - All can break separately = good
  - Potential for a lot of effects going off at once = bad



# **Destruction:** Chain Reactions

- **Tessellation Factor control**
  - Controls amount of triangles inside the sprites
  - Tris reduce when GPU cost starts to spike



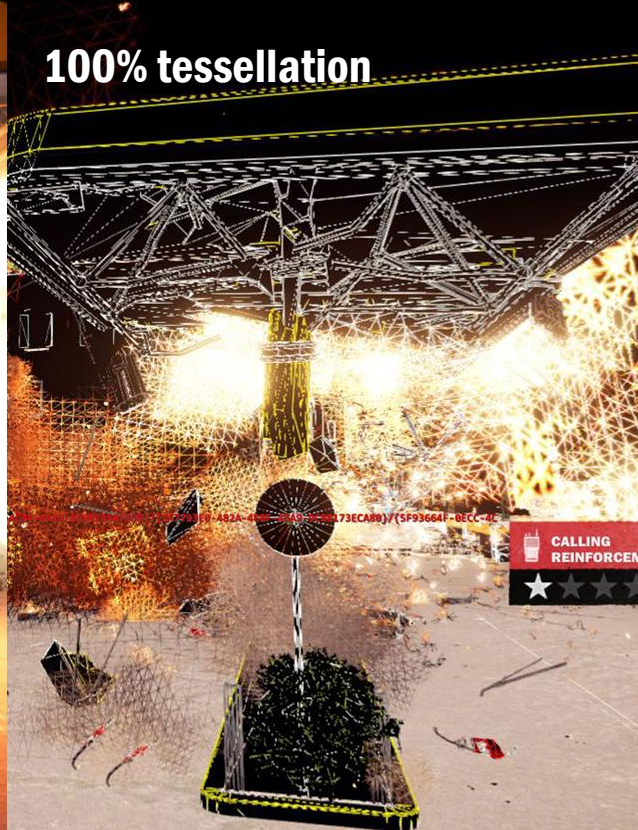


# **Destruction:** Chain Reactions

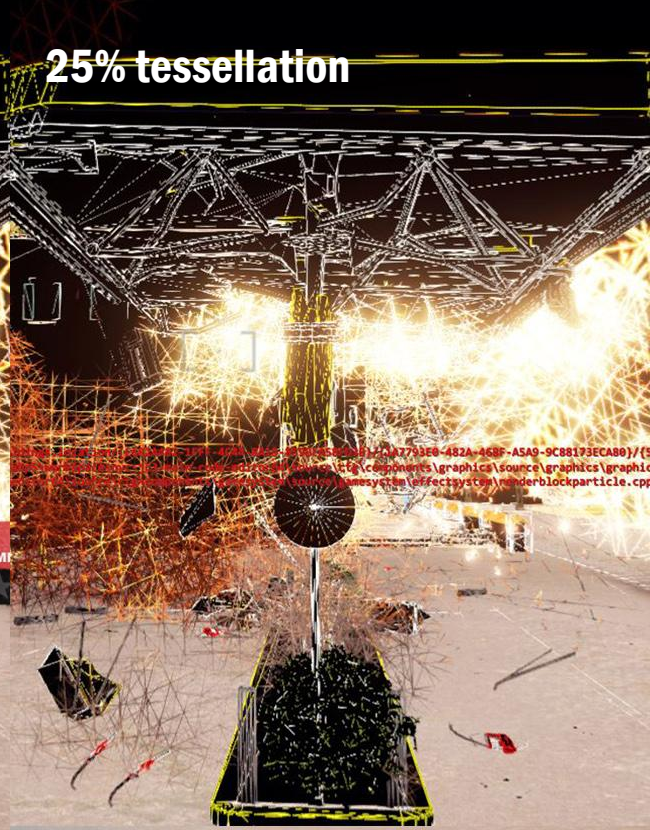
**Explosion**



**100% tessellation**



**25% tessellation**





# **Destruction:** Chain Reactions

- **Effect System Dynamics Manager**
  - When action gets too heavy (10ms spike)
    - Cut low scale particles and blend out low alpha particles





# havok® Destruction








# havoK® Destruction: Overview

- Procedural destruction effects
  - Fractures
  - Impacts
  - Slides
  - Filters

destruction\_effect\_settings\_concrete\_statue.etune 

destruction\_effect\_settings\_con (DestructionEffects)

☒ DebrisImpact (CombinedEffectSettings)

MinImpulseVelocity 0.1000000149

MaxImpulseVelocity 20.0

MaxImpulseMass 1.0

MinScrape 0.119999997318

MaxScrape 10.0

FilterTime 0.20000000298

MinRadius 0.5

MaxRadius 1.0

Priority 1.0

MaxRingTime 0.0

☐ SmallPieceImpact (CombinedEffectSettings)

☐ SmallPieceWaterImpact (CombinedEffectSettings)

☐ SmallPieceSliding (CombinedEffectSettings)

☐ SmallFracture (CombinedEffectSettings)

☐ BigPieceImpact (CombinedEffectSettings)

☐ BigPieceSliding (CombinedEffectSettings)

☐ BigPieceWaterImpact (CombinedEffectSettings)

☐ BigFracture (CombinedEffectSettings)

☐ PieceDestroyed (CombinedEffectSettings)

BigPieceMass 800.0

BigFractureMass 800.0







# **havok** Destruction: Fractures

- **Big Fracture FX**
  - AABB effect (Axis Aligned Bounding Box)
  - When large piece breaks into small piece
- **Fracture FX**
  - Effects play for small piece break and destruction
    - Effects are filtered based on their mass in tuning file



# **havok** Destruction: Impacts & Slides

- **FX Big Impacts and Impacts**
  - Effects spawned from material table (dirt, water, etc)
- **FX Big Slides and Slides**
  - Slide effects occur when an object slides over a surface. The effects trail behind the object.







# **havok® Destruction: Filters**

- **What is the PhysicsImpulse Parameter?**
  - **Havok® touch return raw impulse**
  - **Each piece has a mass value**
  - **Divide impulse by mass to get approximate velocity**
    - **That velocity is the touch value**
  - **Rescale to 0 – 1 for normalized use**
  - **= final impulse scale = physics impulse**



# havok<sup>®</sup> Destruction: Filter

- **Filtering: how we cull impulse effects**
  - Impulse (how hard of a hit to register)
  - Scrape (how much of a slide to register)



# havok® Destruction: Filter

- **Filtering: how we cull impulse effects**
  - Impulse (how hard of a hit to register)
  - Scrape (how much of a slide to register)
  - Radius (overlapping spheres do not play fx)





# havok® Destruction: Filter

- **Filtering: how we cull impulse effects**
  - Impulse (how hard of a hit to register)
  - Scrape (how much of a slide to register)
  - Radius (overlapping spheres do not play fx)
  - Filter Time (How long the radius lasts)



# havok® Destruction: Filter

- **Filtering: how we cull impulse effects**
  - Impulse (how hard of a hit to register)
  - Scrape (how much of a slide to register)
  - Radius (overlapping spheres do not play fx)
  - Filter Time (How long the radius lasts)
  - Priority (Cull low priority effects game scene too expensive)



# **Destruction:** Fun with Physics

- Rigid body
- Havok® Destruction







# Automobiles: Deformable

Clean



Yeesh!







# Automobiles: Wheels

RainPrecipitation : 0.000000 (0.000000 to 0.000000)  
[0x000000001E117403] : 0.817414 (0.000000 to 1.000000)  
[0x0000000066102C9B] : 0.000000 (0.000000 to 0.931325)  
[0x0000000067E5BADA] : 0.000000 (0.000000 to 1.622323)  
[0x00000000724427C3] : 38.850994 (0.000000 to 96.668236)  
[0x000000007A80108E] : 0.000000 (0.000000 to 1.000000)  
Velocity : 13.851217 (0.000000 to 34.717328)  
OffsetEmitter : 0.000000 (0.000000 to 0.000000)



MUGELLO RAFFINATI VITESSE

rear\_asphalt  
Speed : 14.025820  
RainPrecipitation : 0.000000  
WheelRoll : 39.221336  
Skid : 0.000000  
Velocity : -7.467673 3.681515 -11.286429  
Slip : 0.000000  
Suspension : 0.764685  
SpinVelocity : -0.011090  
Spin : 0.000000  
OffsetEmitter : 0.000000

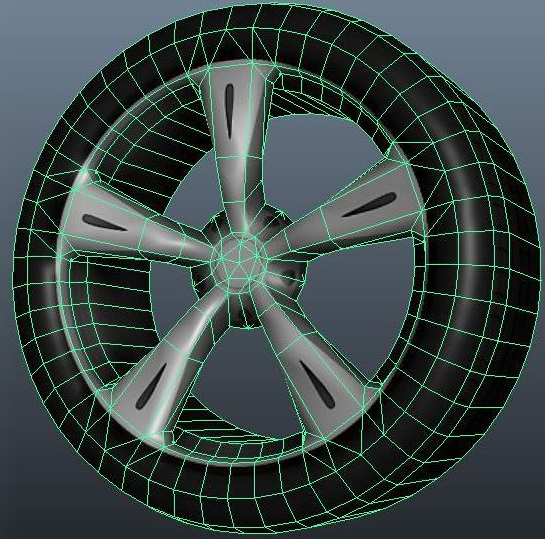


# Automobiles: Wheel Breakdown

Viewport 2.0

Easy parameters Toggles:

Rain Precipitation: is it raining or not





# Automobiles: Wheel Breakdown

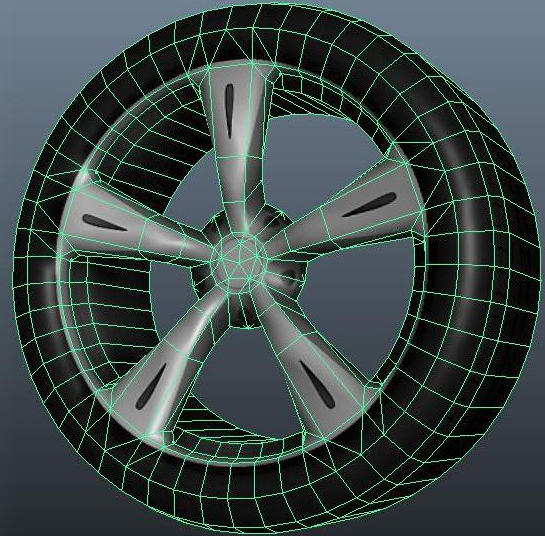
Viewport 2.0

## Automobile Parameters:

**Speed:** What is the overall forward momentum of the car (float)

**Velocity:** What is the automobile's overall velocity (3 vector)

**Suspension:** how much pressure is the automobile putting on the wheel.



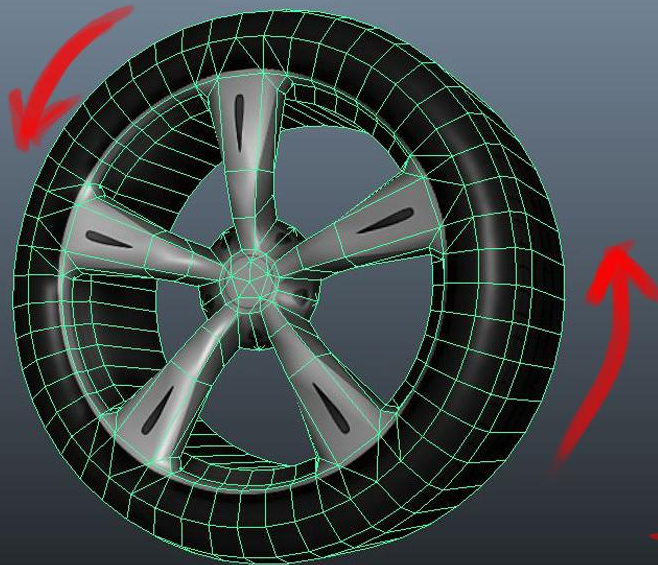


# Automobiles: Wheel Roll

Wheel Roll

Wheel turn speed = road speed

Toggled for soft vs. hard surface



Example:

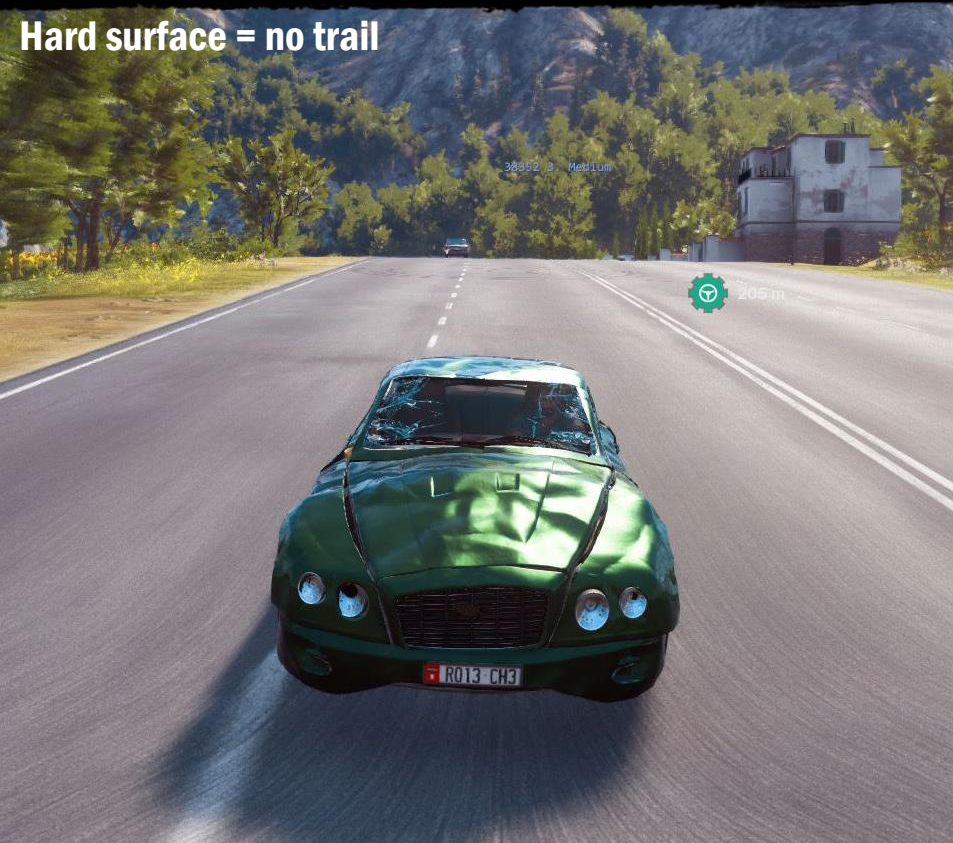
Wheel Roll: 100

Road Speed: 100

Relative Speed when rolling : 0

# Automobiles: Wheel Roll

Hard surface = no trail



Soft surfaces = dust trail



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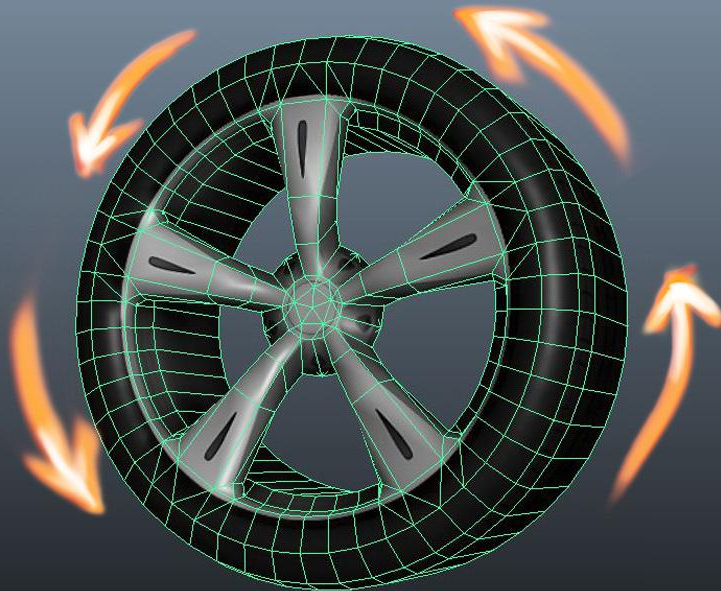
# Automobiles: Wheel Spin

## Spin

Wheel turn speed faster than road speed.

## SpinVelocity

What is the absolute velocity of the actual wheel



**Example:**

**Wheel Roll: 200**

**Road Speed: 100**



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# Automobiles: Wheel Spin

**Spin:** Kick up emitters for wheel spin.

**Change scale, spawn rate and lifetime based on spin and spinvelocity**

**Some overlap, so the wheels get tricky**



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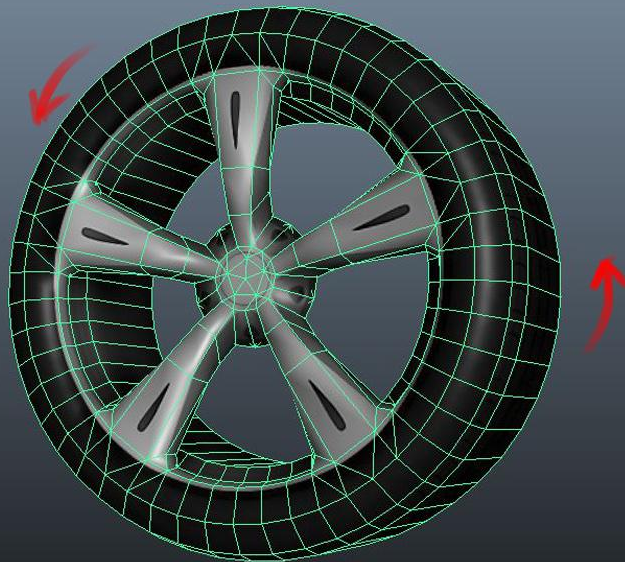
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# Automobiles: Wheel Skid

Skid

Wheel turn speed slower than  
road speed

Hybrid parameter



Example:

Wheel Roll: 100

Road Speed: 200



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# Automobiles: Wheel Skid

Skid (hybrid parameter)

Wheel turn speed slower  
than road speed

Lateral is added into skid  
hybrid.

If wheel is locked up it's a  
skidding patch



Example:

Wheel Roll: 100

Road Speed: 200

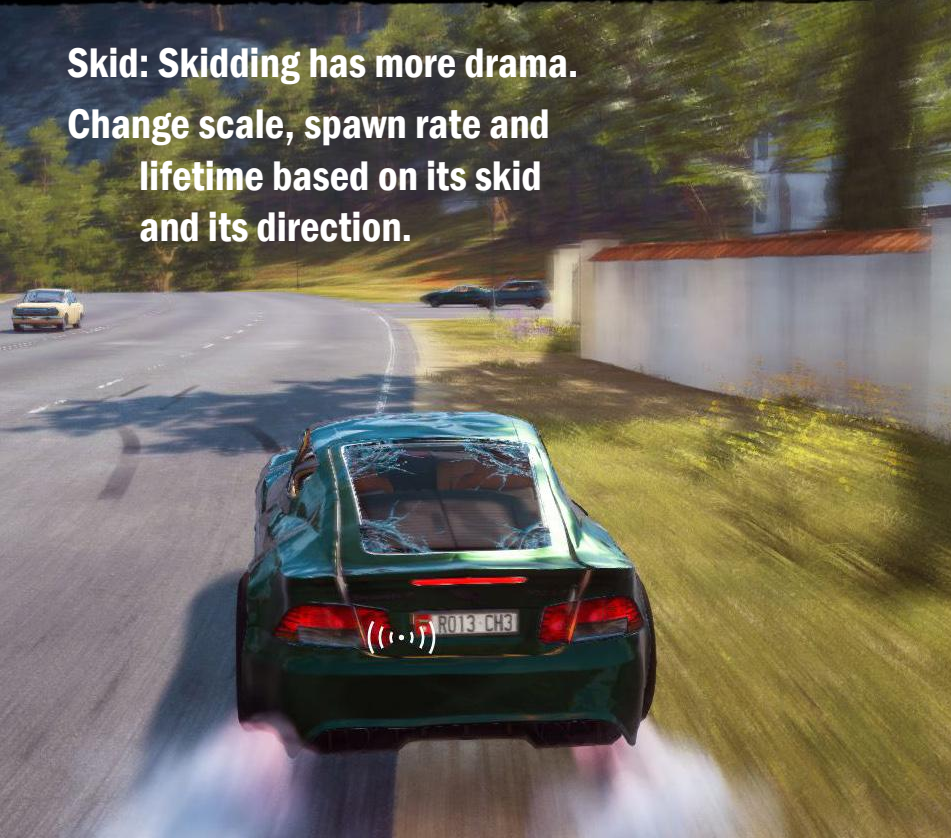


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# Automobiles: Wheel Skid

Skid: Skidding has more drama.  
Change scale, spawn rate and  
lifetime based on its skid  
and its direction.











**Avalanche is Recruiting**



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# Questions ?



- **Overlook 2022, West Hall**



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